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(54) Three-temperature type refrigerator

(57) A three-temperature type refrigerator of a construction, in which a freezing compartment 2, a low temperature chamber 15, and a refrigerating compartment 8 are arranged from top to bottom in the sequence as designated, an evaporator 4 is vertically disposed at the rear surface side of the freezing compartment 2 and the low temperature chamber 15, and in which cool air from the evaporator 4 is blown out into the low temperature chamber 15 either indirectly (as shown) from the freezing compartment 8 through an air outlet duct 22 or, (Figure 4 not shown), directly via a cool air passageway (5*d*) defined in a partition wall 5 disposed at the front surface side of the evaporator 4 facing the freezing compartment 2, through an air outlet duct (39) defined in an intermediate partition 9 wall dicretely defining the freezing compartment 2 and the low temperature chamber 15.

FIGURE 2

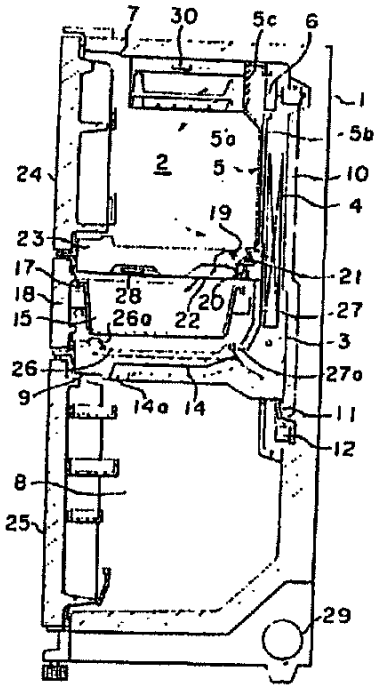

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FIGURE 1

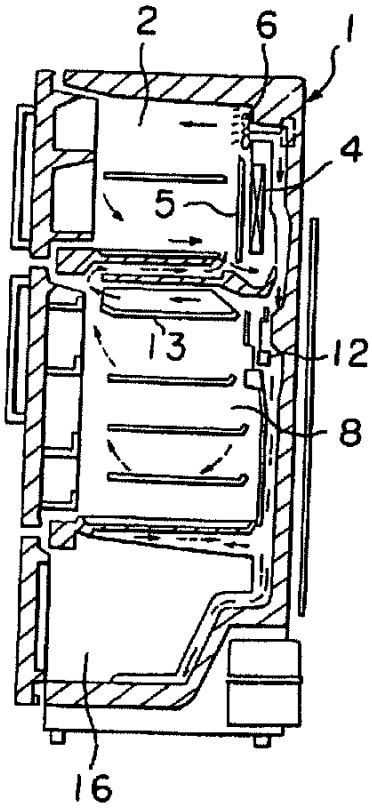

FIGURE 2

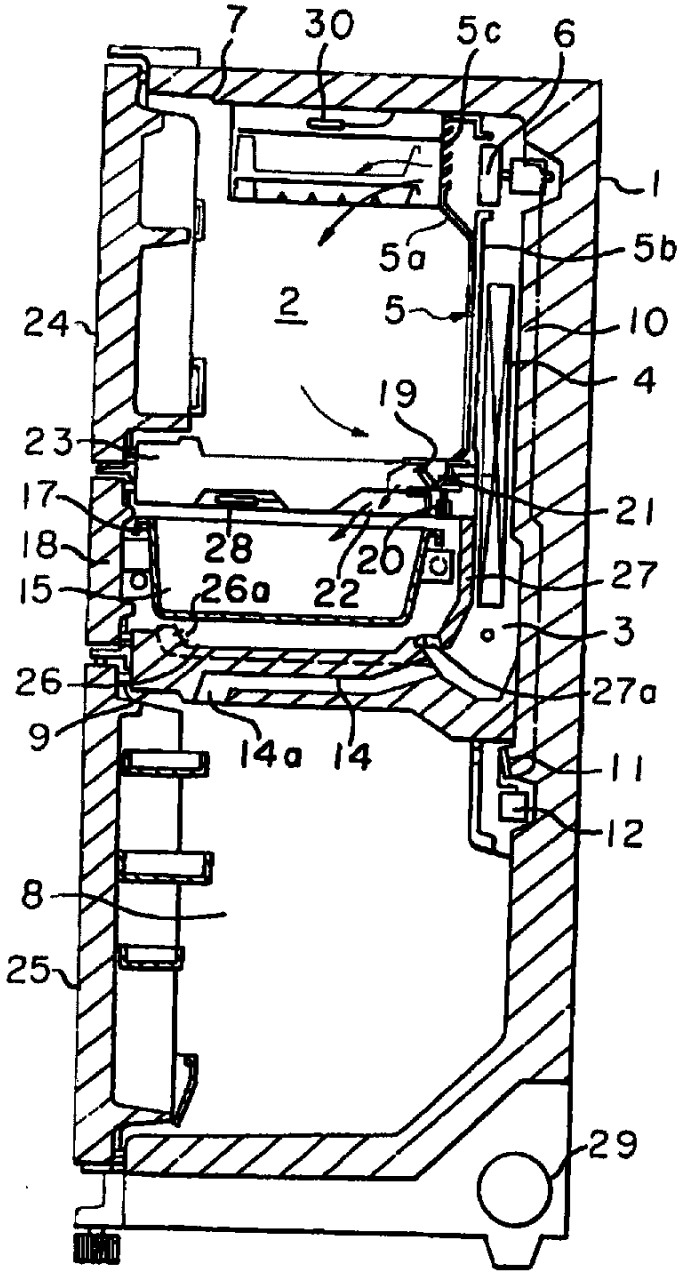

FIGURE 3

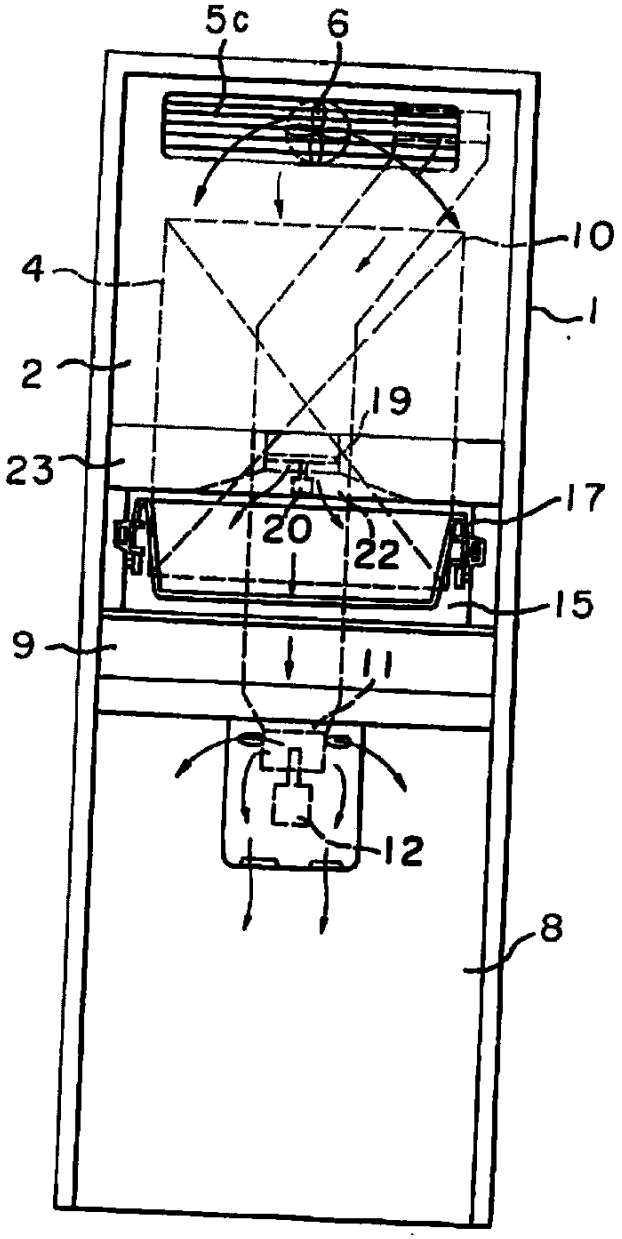

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FIGURE 4

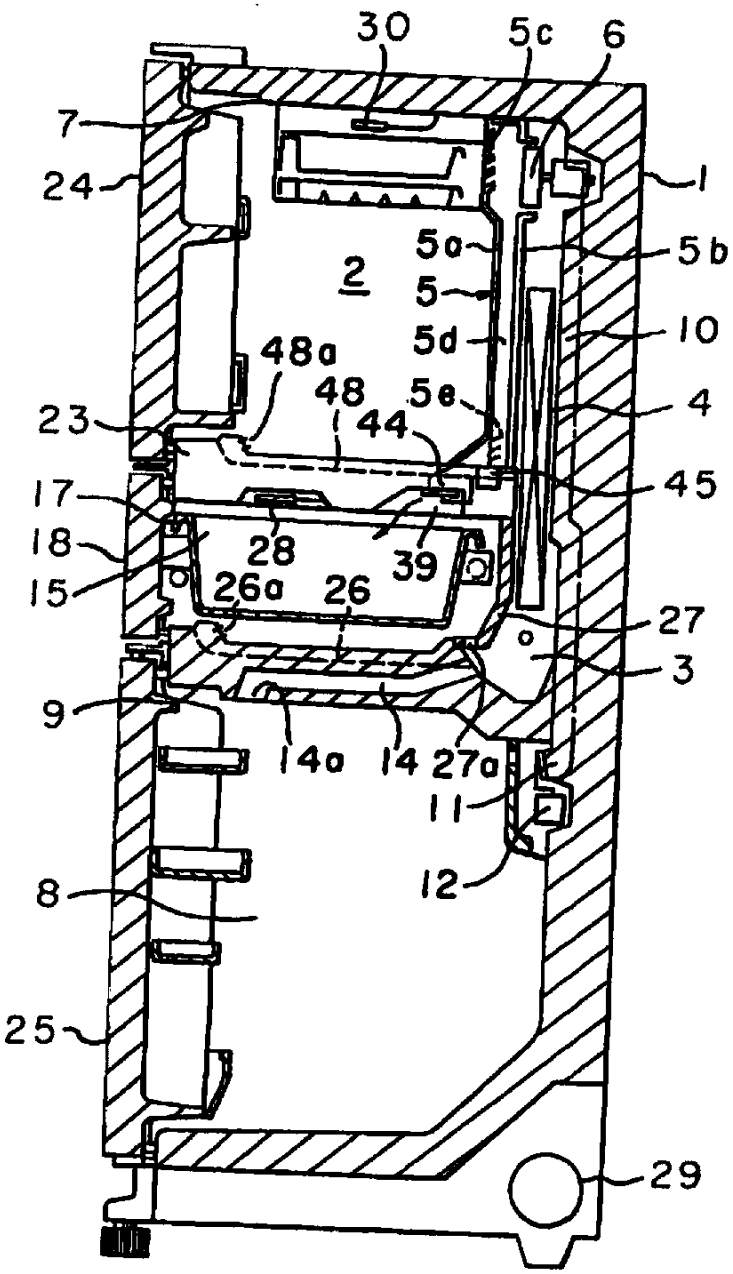
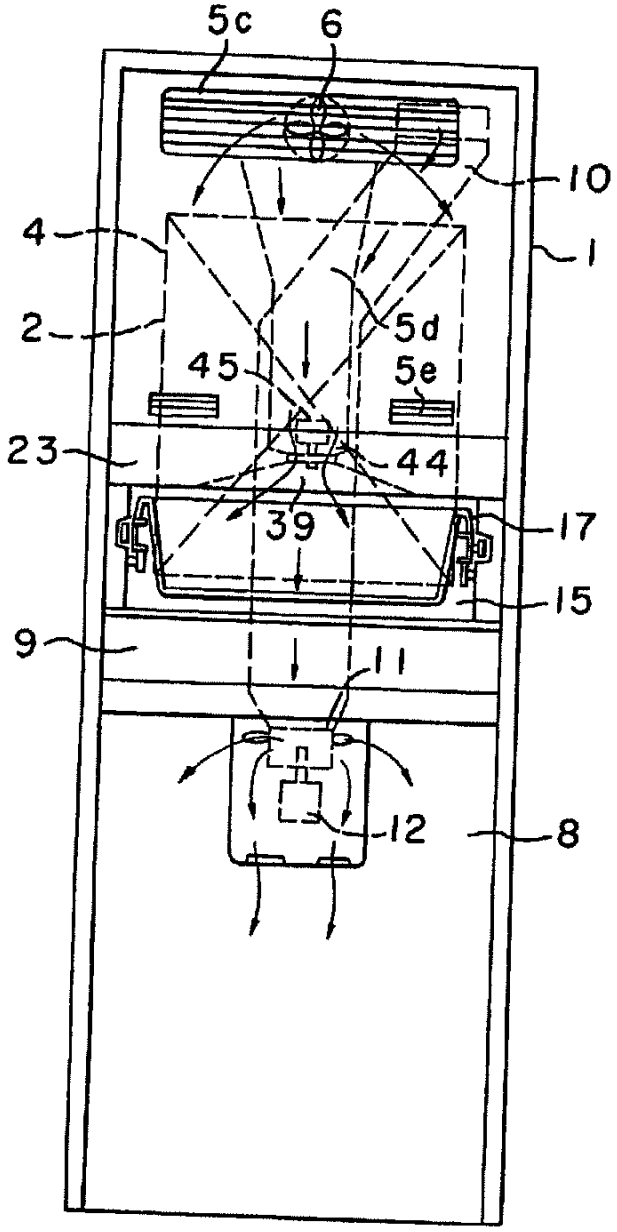


FIGURE 5



SPECIFICATION

Three-temperature type refrigerator

This invention relates to a three-temperature type refrigerator, a refrigerator having three compartments, each being at a different temperature.

There has so far been known a refrigerator of this type as disclosed, for example, in unexamined Japanese utility model publication No. 54874/1980. Such type of refrigerator will be explained in reference to Figure 1 of the accompanying drawing. Within the refrigerator main body 1, there are discretely defined, in sequence from top to bottom, a freezing compartment 2, a refrigerating compartment 8, and a vegetable compartment 16, each of these freezing compartment 2, refrigerating compartment 8 and vegetable compartment 16 being provided with an exclusive door for it. On the upper part of the refrigerating compartment 8, there is disposed a low temperature chamber 13; at the rear surface side of the freezing compartment 2, there is disposed a condenser 4 for the freezing cycle; above the condenser 4, there is disposed a fan 6 for forced circulation of the cooled air; and within the passage for the cool air which serves to pass the cooled air from the condenser 4 downward therethrough, there is disposed a thermo-damper 12 for controlling temperature of the refrigerating compartment 8.

In the refrigerator of the above-described construction, the cool air which has been cooled down by the condenser 4 is circulated in the freezing compartment 2 by the fan 6 to lower the temperature in the compartment, while the cool air controlled by the thermo-damper 12 provided in the cool air passageway is forwarded into the refrigerating compartment 8, the vegetable compartment 16 and the low temperature chamber 13 for circulation therethrough, whereby these compartments are cooled.

In the conventional refrigerator of the above-described construction, since the temperature in these refrigerating compartment 8, vegetable compartment 16, and low temperature chamber 13 is governed by a quantity of the cool air as established beforehand by the dimension of the cool air passageway, they cannot be controlled independently of each other, but are controlled by the thermo-damper 12 which is regulated by the temperature of the refrigerating compartment 8. As the consequence of this, the low temperature chamber 13, for example, which is required to be precisely controlled its temperature for storage of provisions is governed by the temperature of the refrigerating compartment 8. In other words, when the refrigerating compartment is vigorously cooled, the low temperature chamber 13 would inevitably be cooled excessively, and inversely, when the refrigerating compartment 8 is cooled slightly, the low temperature chamber 13 would not be cooled sufficiently, hence it is difficult to control this low temperature chamber in a predetermined temperature range. Further, the low temperature chamber 13 is readily subjected to its temperature variations owing to opening and closing operations of the door, an external temperature, and an operating factor of the compressor, hence its precise temperature-control is problematically difficult.

The primary object of the present invention is to provide a three-temperature type refrigerator which is capable of controlling easily and precisely the low temperature chamber provided between the freezing compartment and the refrigerating compartment in a predetermined temperature range independently of the refrigerating compartment, thereby improving storability of the provisions in the low temperature chamber.

The secondary object of the present invention is to provide an improved three-temperature type refrigerator which is capable of readily controlling the temperature of the low temperature chamber in a predetermined temperature range independently not only of the refrigerating compartment, but also of the freezing compartment, thereby further improving storability of the provisions in the low temperature chamber.

The third object of the present invention is to provide an improved three-temperature type refrigerator which has small heat loss, and is capable of readily maintaining the low temperature chamber at a predetermined temperature level.

According to the present invention, in one aspect of it, there is provided a three-temperature type refrigerator, wherein a freezing compartment, a low temperature chamber, and a refrigerating compartment are defined and shaped within the main body of the refrigerator in the mentioned sequence from top to bottom, and cool air which has been cooled by a condenser is caused to flow and circulate in these freezing compartment, low temperature chamber and refrigerating compartment, the refrigerator being characterized in that the condenser is disposed vertically at the rear surface side of the freezing compartment and the low temperature chamber, that the front side of the condenser facing the freezing compartment and the low temperature chamber is covered with a partition wall, that, within an intermediate partition wall for discretely defining the freezing compartment and the low temperature chamber, there is provided a common duct branched into an air inlet duct for returning the cool air to the condenser side from the freezing compartment and an air outlet duct for blowing the cool air into the low temperature chamber, and that a thermo-damper is provided within this common duct.

According to the present invention, in another aspect of it, there is provided a three-temperature type refrigerator, wherein a freezing compartment, a low temperature chamber, and a refrigerating compartment are defined and shaped within the main body of the refrigerator in the mentioned sequence from top to bottom, and cool air which has been cooled by a condenser is caused to flow and circulate separately in these freezing compartment, low temperature chamber, and refrigerating compartment, the refrigerator being characterized in that the condenser is disposed vertically at the rear surface side of the freezing compartment and the

low temperature chamber, that the front side of the condenser facing the freezing compartment is covered with a partition wall, within which partition wall, a cool air passageway is formed, that an air outlet duct, in which the cool air is blown from the cool air passageway, is formed within an intermediate partition wall defining the freezing compartment and the low temperature chamber, and that a cool air outlet port open to the low temperature chamber is formed in this air outlet duct.

A couple of ways of carrying out the invention are described in detail hereinbelow with reference to the accompanying drawings which illustrate preferred embodiments, in which:-

Figure 1 is a longitudinal cross-sectional view of a conventional three-temperature type refrigerator;

Figure 2 is a longitudinal cross-sectional view showing the first embodiment of the present invention;

Figure 3 is a front view showing the main parts of the refrigerator shown in Figure 2 with the doors being removed;

Figure 4 is a longitudinal cross-sectional view of the second embodiment of the present invention; and

Figure 5 is a front view showing the main parts of the refrigerator shown in Figure 4 with the doors being removed.

In the following, the present invention will be described with reference to the first embodiment thereof shown in Figures 2 and 3.

In Figures 2 and 3, a reference numeral 1 designates the main body of the refrigerator, and a numeral 2 refers to a freezing compartment disposed on the topmost part in the main body 1. The freezing compartment 2 is maintained at a temperature of −18°C or below (a temperature capable of preserving frozen foods) by on-off control of a compressor 29 for the freezing cycle with a temperature sensor 30. A reference numeral 3 designates a cooling chamber defined at the rear surface side of the freezing compartment 2 and a low temperature chamber 15 arranged beneath the freezing compartment 2. Within this cooling chamber 3, there is accommodated a condenser 4 for the freezing cycle, which is lodged vertically along and over the rear surface of the freezing compartment 2 and the low temperature chamber 15. A reference numeral 5 designates a partition wall disposed at the front surface side of the cooling chamber 3. This partition wall 5 is composed of a decorative panel 5a and a heat insulating material 5b, both of which are put together and arranged in the front-to-rear direction, i.e., in the direction of the depth of the refrigerator. On the top part of the partition wall 5, there is formed cool air outlet ports 5c which are communicatively connected to the cooling chamber 3. Further, the front surface side of the condenser 4 facing the freezing compartment 2 is covered with the decorative panel 5a and heat insulating material 5b. A numeral 6 refers to a cool air circulating fan disposed in the cooling chamber 3 in contiguity to the cool air outlet ports 5c above the condenser 4. A numeral 7 refers to an inner casing to constitute a refrigerating compartment 8, and others. A reference numeral 9 denotes an intermediate partition wall to discretely define the low temperature chamber 15 and the refrigerating compartment 8 disposed beneath the low temperature chamber 15. A numeral 10 refers to an air outlet duct extending from the upper rear surface side of the cooling chamber 3 to the upper rear surface side of the refrigerating chamber 8; a numeral 11 denotes an air outlet port of the air outlet duct 10 into the refrigerating compartment 8; and a numeral 12 refers to a thermo-damper for the refrigerating compartment, which is provided in the vicinity of the air outlet port 11, the cool air passing through the air outlet duct 10 to be blown out of the air outlet port 11 into the refrigerating compartment 8, while it is being controlled by the thermo-damper 12 for the refrigerating compartment, thereby maintaining the refrigerating compartment 8 at a predetermined refrigerating temperating. A numeral 14 refers to an air inlet duct formed within the intermediate partition wall 9, with its air inlet port 14a being open to the lower front surface side of the intermediate partition wall 9. This air inlet duct 14 is so arranged that it is communicatively connected to the lower end part of the cooling chamber 3 to enable the cool air to be fed back from the refrigerating chamber 8 into the cooling chamber 3 through this air inlet duct 14. A reference numeral 17 designates a vessel which is placed in the low temperature chamber 15, and which can be drawn out in association with a front door 18 of the low temperature chamber 15. A numeral 19 denotes a common duct, the upper part of which is open to the upper rear side surface of the intermediate partition wall 23 discretely defining the freezing compartment 2 and the low temperature chamber 15, and the lower part of which is branched into an air inlet duct 21 and an air outlet duct 22. The air inlet duct 21 is communicatively connected to the cooling chamber 3, while the air outlet duct 22 is communicatively connected to the upper part of the low temperature chamber 15. Further, at the branched portion in this common duct 19, there is provided a change-over thermo-damper 20 which is so constructed that it may be switched into a state wherein the cool air which has cooled down the freezing compartment 2 is returned to the cooling chamber 3 through the air inlet duct 21, and another state wherein the cool air is blown out into the low temperature chamber 15 through the air outlet duct 22. A numeral 26 refers to an air inlet duct formed within the intermediate partition wall 9, with its air inlet port 26a being open to the upper front surface side of the intermediate partition wall 9. This air inlet duct 26 is communicatively connected to the lower end part of the cooling chamber 3 to enable the cool air to be fed back from the low temperature chamber 15 to the cooling chamber 3 through this air inlet duct 26. A reference numeral 27 denotes a partition wall at the rear side of the low temperature chamber 15. An air inlet port 27a is formed at a lower part of this partition wall 27 so as to return the cool air blown out into the low temperature chamber 15 into the

cooling chamber 3 from the air inlet port 27a, too. By the way, in Figure 2, a numeral 28 refers to a temperature sensing part of the change-over thermo-damper 20, and 24 and 25 designate respectively the doors for the freezing compartment 2 and the refrigerating compartment 8.

In the following, explanations will be given as to the operations of the above-described three-temperature type refrigerator according to the first embodiment of the present invention. The cool air as cooled by the condenser 4 is blown out into the freezing compartment 2 through the air outlet ports 5c in the upper part of the partition wall 5. After it has cooled down the freezing compartment 2, the cool air returns to the cooling chamber 3 from the common duct 19 by way of the air inlet duct 21, when the switching thermo-damper 20 is in the state of opening this air inlet duct 21. The interior of the freezing compartment 2 is thus maintained at a temperature level capable of preserving frozen foods by the on-off control of the compressor 29 through the steps of sensing the temperature within the freezing compartment 2 by the temperature sensor 30 and operating a temperature regulator for the freezing compartment. Moreover, a part of the cool air which has been cooled by the condenser 4 passes through the air outlet duct 10 to be blown out into the refrigerating compartment 8 through the air outlet port 11. After it has cooled down the refrigerating compartment 8, the cool air returns to the cooling chamber 3 through the air inlet duct 14 in the intermediate partition wall 9, whereby the interior of the refrigerating compartment 8 is maintained by the thermo-damper 12 for the refrigerating compartment at a temperature of 3°C to 4°C suitable for chilling foods. When the switching thermo-damper 20 is changed over to a state of opening the air outlet duct 22, the cool air which has cooled down the freezing compartment 2 passes through the common duct 19 and the air outlet duct 22 to be blown out into the low temperature chamber 15. After it has cooled down the low temperature chamber 15, the cool air returns to the cooling chamber 3 through the air inlet port 27a in the partition wall 27 and the air inlet duct 26 in the intermediate partition wall 9. The interior of the low temperature chamber 15 is maintained at a temperature of from −1°C to +1°C suitable for preserving foods at such low temperature by the change-over control of the switching thermo-damper 20 through the step of sensing the temperature in the low temperature chamber 15 by the temperature sensing part 28 located on the upper part of the low temperature chamber 15, which stands for the lower surface part of the intermediate partition wall 23.

The three-temperature type refrigerator according to this embodiment is so constructed that the freezing compartment 2, the low temperature chamber 15, and the refrigerating compartment 8 are arranged from top to bottom in the order as mentioned, and the temperature control device such as the thermo-dampers 12, 20, and the temperature regulator for the freezing compartment are provided in each of these compartments and chamber. As the consequence of this, the temperature in each storage space (in particular, the low temperature chamber 15) can be controlled with high precision to thereby be able to safely preserve the foods in good condition. Furthermore, since the air inlet ports 27a and 26a of the low temperature chamber 15 are respectively formed in the rear partition wall 27 and the upper front surface side of the intermediate partition wall 9 between the low temperature chamber 15 and the refrigerating compartment 8, no irregularity occurs in the temperature distribution within the low temperature chamber 15, whereby the temperature therein can be maintained uniformly.

As has been explained in the foregoing, since the first embodiment of this invention is so constructed that the freezing compartment, the low temperature chamber, and the refrigerating compartment are arranged from top to bottom in the sequence as mentioned, and that, by providing the intermediate partition wall discretely defining the freezing compartment and the low temperature chamber, the common duct which is open to the freezing compartment is branched and the branched ducts are changed over by the thermo-damper provided in this common duct into a state wherein the cool air which has cooled down the freezing compartment is returned to the condenser through the air inlet duct, and another state wherein the cool air is blown out into the low temperature chamber through the air outlet duct, it becomes possible to precisely control the temperature in the low temperature chamber, hence to stably store the foods. Moreover, according to the present invention, the low temperature chamber can also be readily utilized as the freezing compartment by forcibly maintaining the thermo-damper in a state of its bringing the freezing compartment and the low temperature chamber into a serial communication between them. In addition, according to the present invention, since the low temperature chamber is disposed between the freezing compartment and the refrigerating compartment, and the condenser is provided at the rear surface side of the freezing compartment and the low temperature chamber, there can be realized remarkable effects such that the heat loss is kept to the minimum and the low temperature chamber is easily maintained at a predetermined temperature level.

In the following, explanations will be given as to the second embodiment of the present invention in reference to Figures 4 and 5. It should be noted that the same reference numerals in Figures 4 and 5 designate the identical parts in Figures 2 and 3, hence explanations of these parts will be dispensed with.

Referring to the drawing, the partition wall 5 is composed of the decorative panel 5a and the heat insulating material 5b, both of which are arranged in the front-to-rear direction, i.e., in the direction of the depth of the refrigerator. A cool air passageway 5d is defined between the decorative panel 5a and the heat insulating material 5b. The cool air

outlet ports 5c are formed in the upper part of the partition wall 5, and air inlet ports 5e in the lower part thereof, these air inlet and outlet ports being communicatively connected to the cooling chamber 3. A reference numeral 39 designates an air outlet port of the low temperature chamber 15; a numeral 44 refers to an air outlet duct which is defined at the rear surface side in the intermediate partition wall 23 to communicate the cool air passageway 5d to the air outlet port 39; and 45 denotes an electromagnetic thermo-damper for the low temperature chamber, which is provided in the vicinity of the air outlet port 39 of the air outlet duct 44, the cool air passing through the cool air passageway 5d and the air outlet duct 44 to be blown out from the air outlet port 39 into the low temperature chamber 15 by control of the thermo-damper 45 for the low temperature chamber 45. A reference numeral 48 designates an air inlet duct formed in the intermediate partition wall 23, with its air inlet port 48a being open to the upper front surface side of the intermediate partition wall 23 discretely defining the freezing compartment 2 and the low temperature chamber 15, the other end of this duct 48 being communicatively connected to the cooling chamber 3 to enable the cool air to be fed back to the cooling chamber 3 from the freezing compartment 2 through the air inlet duct 48.

In the following, explanations will be given as to the operations of the three-temperature type refrigerator of the above-described construction according to the second embodiment of the present invention. The cool air which has been cooled down by the condenser 4 is blown out by the cool air circulating fan 6 into the freezing compartment 2 through the air outlet port 5c in the upper part of the partition wall 5. After it has cooled down the freezing compartment 2, the cool air returns to the cooling chamber 3 through the air inlet port 5e of the partition wall 5 and the air inlet duct 48 of the intermediate partition wall 23. A part of the cool air which has been cooled down by the condenser 4 passes through the air outlet duct 10 and is blown out into the refrigerating compartment 8 from the air outlet port 11. After it has cooled down the refrigerating compartment 8, the cool air returns to the cooling chamber 3 through the air inlet duct 14 of the intermediate partition wall 9, whereby the interior of the refrigerating compartment 8 is maintained at a temperature of from 3°C to 4°C suitable for refrigerating foods by the thermo-damper 12 for the refrigerating chamber. Further, the other part of the cool air which has been cooled down by the condenser 4 passes through the cool air passageway 5d formed in the partition wall 5 at the rear surface side of the refrigerating compartment 2 and is blown out into the low temperature chamber 15 from the air outlet port 39 through the intermediate partition wall 23 and the air outlet duct 44 at the rear surface side thereof. After it has cooled down the low temperature chamber 15, the cool air goes back into the cooling chamber 3 through the air inlet port 27a of the partition wall 27 and the air inlet duct 26 of the intermediate partition wall 9. The interior of the low temperature chamber 15 is thus maintained at a temperature of from −1≡C to +1°C suitable for chilling foods for preservation by controlling the thermo-damper 45 for the low temperature chamber through the step of sensing the temperature within the low temperature chamber 15 by the temperature sensing part 28 disposed on the upper part of the low temperature chamber 15, which stands for the lower surface part of the intermediate partition wall 23.

Since the three-temperature type refrigerator according to this embodiment is so constructed that the freezing compartment 2, the low temperature chamber 15 and the refrigerating compartment 8 are arranged from top to bottom in the sequence as mentioned, that cool air may be blown out into each of the compartments and chamber independently of each other, and that the temperature regulator for the freezing compartment and the temperature control device as the thermo-dampers 12, 45 are provided in each of these compartments and chamber, the temperature of each storage space (in particular, the low temperature chamber 15) can be controlled with precision, and stable storage of foods can be effected in addition, since the air inlet ports 27a and 26a of the low temperature chamber 15 are provided at the upper front surface side of the intermediate partition wall 9 for the low temperature chamber 15 and the refrigerating chamber 8, there occurs no irregularity in the temperature distribution within the low temperature chamber 15, whereby the temperature within it can be made uniform throughout.

As has been explained in the foregoing, since the second embodiment fo the present invention is so constructed that the freezing compartment, the low temperature chamber, and the refrigerating compartment are arranged from top to bottom in the sequence as designated, and that the cool air may be blown out into each of these compartments and chamber independently of each other, it becomes possible to carry out the independent temperature control in each compartment and chamber, whereby the temperature in the freezing compartment, the refrigerating compartment, and, in particular, the low temperature chamber can be controlled precisely, hence stable storage of provisions can be attained. Furthermore, according to the present invention, since the low temperature chamber is disposed between the freezing compartment and the refrigerating compartment, and the condenser is provided at the rear surface side of the freezing compartment and the low temperature chamber, there can be obtained remarkable effects such that the heat loss can be kept to the minimum and the temperature in the low temperature chamber can be easily maintained at a predetermined temperature level.

CLAIMS

1. A three-temperature type refrigerator, wherein a freezing compartment, a low temperature chamber, and a refrigerating compartment are respectively defined and shaped from top to bottom within the main body of the refrigerator in the

sequence as designated, and cool air which has been cooled down by a condenser is caused to flow and circulate in said freezing compartment, said low temperature chamber, and said refrigerating compartment, characterized in that said condenser is disposed vertically at the rear surface of said freezing compartment and said low temperature chamber, that the front surface side of said condenser facing said freezing compartment and said low temperature chamber is covered with a partition wall, that a common duct branched into an air inlet duct for returning the cool air from said freezing compartment to the side of said condenser and an air outlet duct for blowing the cool air out into said low temperature chamber is provided within an intermediate partition wall for discretely defining said freezing compartment and said low temperature chamber, and that a thermo-damper is provided in said common duct.

2. A three-temperature type refrigerator according to Claim 1, characterized in that said low temperature chamber is so constructed as to enable the cool air to be returned to the side of said condenser through an air inlet port formed in the lower part of said partition wall covering the front surface side of said condenser facing said low temperature chamber, and through an air inlet duct with an air inlet port thereof being formed in the upper front surface side of said intermediate partition wall discretely defining said low temperature chamber and said refrigerating compartment.

3. A three-temperature type refrigerator according to Claim 1 or 2, characterized in that said partition wall partitioning the front surface side of said condenser facing said freezing compartment is composed of a decorative panel and a heat insulating material, both of which are put together in the front-to-rear direction of said refrigerator.

4. A three-temperature type refrigerator according to Claim 1, characterized in that said refrigerating compartment is so constructed as to enable the cool air to be introduced thereinto through an air outlet duct provided at the rear part of said condenser, and to enable said cool air to be returned to the side of said condenser through an air inlet duct with the air inlet port thereof being formed in the lower front surface side of said intermediate partition wall discretely defining said low temperature chamber and said refrigerating compartment.

5. A three-temperature type refrigerator according to Claim 4, characterized in that a thermo-damper for the refrigerating compartment is provided in the vicinity of the air outlet port of the air outlet duct to said refrigerating compartment.

6. A three-temperature type refrigerator, wherein a freezing compartment, a low temperature chamber, and a refrigerating compartment are respectively defined and shaped from top to bottom within the main body of the refrigerator in the sequence as designated, and cool air which has been cooled down by a condenser is caused to flow and circulate separately into each of said freezing compartment, said low temperature chamber, and said refrigerating compartment by means of a fan, characterized in that said condenser is disposed vertically at the rear surface side of said freezing compartment and said low temperature chamber, that the front surface side of said condenser facing said freezing compartment is covered with a partition wall, that a cool air passageway is defined within said partition wall, and that an air outlet duct, into which the cool air is blown from said cool air passageway, is defined in an intermediate partition wall discretely defining said freezing compartment and said low temperature chamber, and that a cool air outlet port open to said low temperature chamber is formed in said air outlet duct.

7. A three-temperature type refrigerator according to Claim 6, characterized in that said air outlet duct formed in said intermediate partition wall is provided in the interior thereof with an electromagnetic type thermo-damper for temperature control in said low temperature chamber.

8. A three-temperature type refrigerator according to Claim 6, characterized in that said refrigerating compartment is so constructed as to enable the cool air to be introduced thereinto through an air outlet duct provided at the rear part of said condenser, and to enable said cool air to be returned to the side of said condenser through an air inlet duct with the air inlet port thereof being formed in the lower front surface side of said intermediate partition wall discretely defining said low temperature chamber and said refrigerating compartment.

9. A three-temperature type refrigerator according to Claim 8, characterized in that a thermo-damper for the refrigerating compartment is provided in the vicinity of the air outlet port of the air outlet duct to said refrigerating compartment.

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